Use of insect meals in ruminant nutrition: protein evaluation

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In Europe, most intensive ruminant feeding systems are highly dependent on soybean meal as the source of protein, which fosters the search for alternatives. Although the use of insect meals has been suggested as one of these alternatives, very few reports have characterised this type of feedstuffs in ruminants. In anticipation of a future authorisation of insect meals for use in practical farming, their protein evaluation would be among the first research needs. Nevertheless, concerns exist about the use of methodologies such as batch cultures of ruminal microorganisms or the *in situ* nylon bag technique, and other options must be tested. The objective of this study was to perform a protein evaluation of 4 insect meals (from *Tenebrio molitor*, *Zophobas morio*, *Alphitobius diaperinus* and *Acheta domesticus*) and of soybean meal (as a reference feedstuff). Three different techniques were employed. First, *in vitro* batch cultures of ruminal microorganisms were carried out with increasing levels of starch, and N degradation was estimated by linear regression (ml of gas vs mg of ammonia-N). The second methodology consisted in estimating N disappearance by filtering the *in vitro* incubation residue, whereas the third approach involved the *in situ* nylon bag technique. The crude protein content of insect meals ranged from 38% in *Z. morio* to 70% in *A. domesticus*. The 3 methodologies appeared to establish a similar ranking among feeds, with very similar results in estimations based on regression or *in situ* techniques, but with higher variation in the *in vitro* assessment. Regardless of the method, insects showed lower protein degradations than soybean meal, ranging from 41-50% in *T. molitor* to 70-78% in *A. diaperinus*. Overall, results supported the potential of insects as alternative ingredients to vegetable feedstuffs in ruminant diets. However, further research would be necessary, for example to characterise their amino acid composition or the fibre-bound nitrogen in their chitin exoskeleton, which might contribute to explain their relatively low protein disappearances.
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The effects of replacing soybean with *Hermetia illucens* on the broiler intestinal tract

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The increasing demand of broiler production has considerable environmental and economic impact, increasing the urgency to find sustainable alternative feed ingredients. Recent studies indicate that some species of insects have great production potential and may be a source of both protein and lipids, which is the case of black soldier fly (BSF) (*Hermetia illucens*). The objective of the current study was to assess the influence of replacing soy with BSF meal on the intestinal tract morphology. Twenty four, 1-day-old Ross 308 broiler were fed four different diets where soybean meal and soybean oil were replaced by 0, 22, 44 and 66% of dry BSF larvae, for 28 days. Broilers were then slaughtered and the intestinal tract was divided into 5 different portions – duodenum, jejunum, ileum, caecum and colon for histopathology analysis. For each intestinal portion, 6-7 transverse systematic uniform random sections were sampled, and processed for routine H&E staining. Morphometric analysis was performed with the ImageJ software and the colour threshold plug in. For each portion, a pathological assessment was performed and the average total section area, mucosal area, percentage of mucosa and caecal tonsil area were determined. The histopathology assessment did not revealed any histological lesion with pathological significance. The morphometric study didn't disclosed differences in the several parameters measured within the same portion of intestine among the different diet groups (Kruskal-Wallis non-parametric test $P>0.05$). Replacement of soy by BSF has no histological or morphometric effect on broiler intestinal tract. Funding: This study was conducted in the scope of the EntoValor project (POCI-01-0247-FEDER-017675).

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USE OF INSECT MEALS IN RUMINANT NUTRITION: PROTEIN EVALUATION

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INTRODUCTION

In Europe, most intensive ruminant feeding systems are highly dependent on **soybean meal** as the source of protein, which fosters the search for alternatives. Although the use of **insect meals** has been suggested as one of these alternatives, very few reports have characterized this type of feedstuffs in **ruminants**. In anticipation of a future authorization of insect meals for use in practical farming, their protein evaluation would be among the first research needs. Nevertheless, concerns exist about the use of methodologies such as batch cultures of ruminal microorganisms or the *in situ* nylon bag technique, and other options must be tested.

The **objective** of this study was to perform a protein evaluation of 4 insect meals (from *Tenebrio molitor*, *Zophobas morio*, *Alphitobius diaperinus* and *Acheta domesticus*) and of soybean meal (as a reference feedstuff).

MATERIAL AND METHODS

Animals: 4 rumen-cannulated sheep, fed a TMR (60:40 forage:concentrate ratio) at 1.1 × maintenance energy requirements

Substrates:

Tenebrio molitor (mealworms)	*Zophobas morio* (morioworms)	*Alphitobius diaperinus* (buffaloworms)	*Acheta domesticus* (adult domestic crickets)	Soybean meal (reference feed)
				

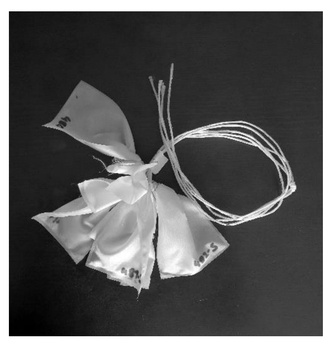
Three different techniques were employed to calculate **N disappearance**

In vitro batch cultures of ruminal microorganisms were carried out with increasing levels of starch, and N degradation was estimated by **linear regression** (mL of gas *vs.* mg of ammonia-N)

Method 1 – *in vitro*
Raab et al. (1983) and Mota et al. (2005)
reg ND

N disappearance was estimated by **filtering** the *in vitro* incubation residue

Method 2 – *in vitro*
Reading Pressure Technique (RPT)
in vitro ND

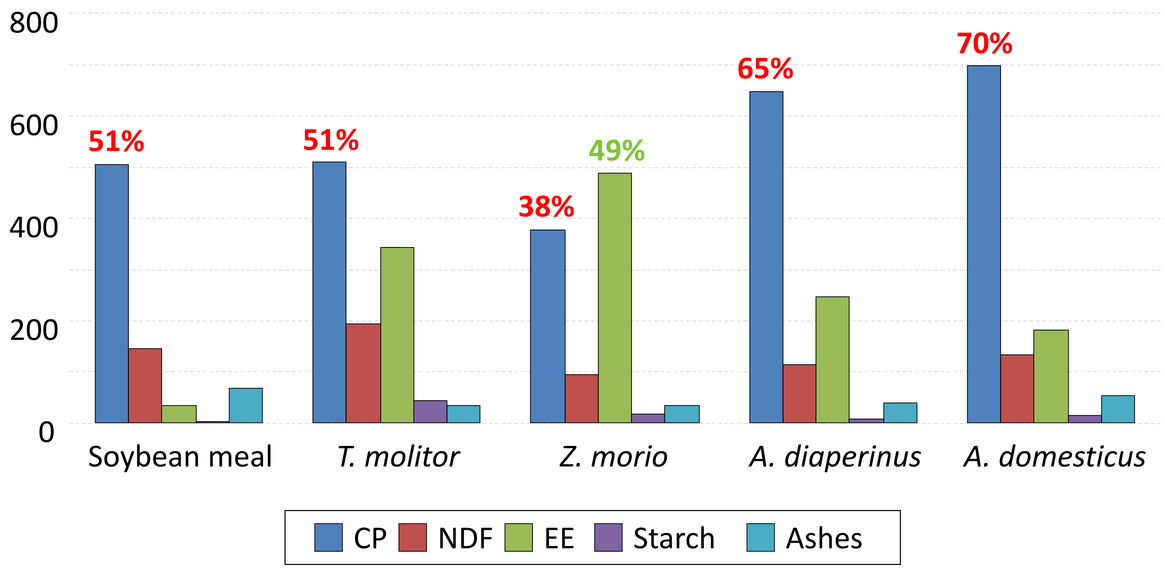


N disappearance was estimated by using *in situ* **nylon bag** technique

Method 3 – *in situ*
Orskov and McDonald (1979)
in situ ND

RESULTS

CHEMICAL COMPOSITION
(g/kg DM)



Insect meals showed a large variation in **CP content**

N DEGRADATION
(g/g)

	reg ND	in vitro ND	in situ ND	
Soybean meal	1.14	0.85	0.91	***
T. molitor	0.50	0.41	0.49	*
Z. morio	0.76	0.56	0.72	***
A. diaperinus	0.70	0.70	0.78	***
A. domesticus	0.73	0.72	0.70	ns
	***	***	***	

The **3 methodologies** appeared to establish a similar ranking among feeds.

Regardless of the **method**, insects showed lower nitrogen disappearances than soybean meal.

CONCLUSION

Results supported the potential of insects as **alternative ingredients** to vegetable feedstuffs in **ruminant diets**. However, further research would be necessary, for example to characterize their amino acid composition or the fiber-bound nitrogen in their chitin exoskeleton, which might contribute to explain their relatively low protein disappearances.

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